Space Weather Technical Forecast

Issued on Thursday, 16 March 2023 at 01:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1-G2/Minor-Moderate Geomagnetic storms from further glancing CMEs on Day 1 (16 March).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Very Low to Low over the past 24 hours with just an isolated C-class flare at 15/0630UTC from AR3254. There are currently eight numbered sunspot regions on the visible disc. These are a mixture of mature spots and some more recently emerged spot groups. All are small and magnetically simple, and either stable or in decay. Some minor new un-numbered spots have emerged in the northwest and southeast of the disc
No Earth directed CME's have been observed in the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar wind increases reflected the arrival of a CME at DSCOVR around 15/0350UTC, with speeds observed at L1 rising sharply from 410 km/s to around 550 km/s. Winds then gradually declined to around 480 km/s, before rising again to around 530km/s in recent hours. The density has been predominantly above average, but saw a sudden jump around 15/0400UTC from 12ppcc to a peak of 35ppcc at 15/0404 UTC. The total IMF strength was often moderate, but increased sharply around 15/0400UTC to strong, with a peak of 26nT at 15/0502UTC. Strong levels continued to around 15/0800UTC. The north-south component was variable fluctuating between +17/-17nT, with a sustained period of moderately strong negative Bz observed 15/2000-2130 UTC. The Phi angle was mostly positive (away from the Sun) but switched to negative (towards the Sun) just before 15/2100UTC. Geomagnetic activity ranged Quiet to G2/Moderate Storm, with a G1/Minor Storm interval observed at 15/0300-0600UTC, and G2/Moderate Storm interval observed at 15/2100-2400UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16, started above the S1 level, likely due to the ongoing effects from the significant far-sided eruption early on 13 Mar, with a peak of 22pfu at 15/0425UTC. Proton flux dropped below the S1 threshold around 15/0600UTC and has been on a downward trajectory. The high energy electron flux (greater than 2MeV) has been at largely background levels, with a peak of 108pfu at 15/1445UTC. The associated 24 hour Electron fluence was well below Active and on a downward trend. At 16/0001UTC the observed fluence was 1.30e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to continue Low or Very Low, with a slight chance of an isolated M-class flare.

Solar Wind / Geomagnetic Activity: Further CME glances are possible on Day 1 (16 Mar) from the combined influence of filament eruption CMEs which left the Sun on 12 and 13 Mar, although these CMEs are expected to pass largely north and ahead of Earth.
Solar winds are expected to vary between slightly elevated and elevated levels through Day 1 (126 Mar), with coronal hole high speed stream effects combined with any further CME influence. Winds are expected to gradually decline into Day 2 (17 Mar), although perhaps remaining at slightly elevated levels throughout much of the rest of the period, with some further weak enhancement possible by the end of Day 4 (19th) from CH85/+.

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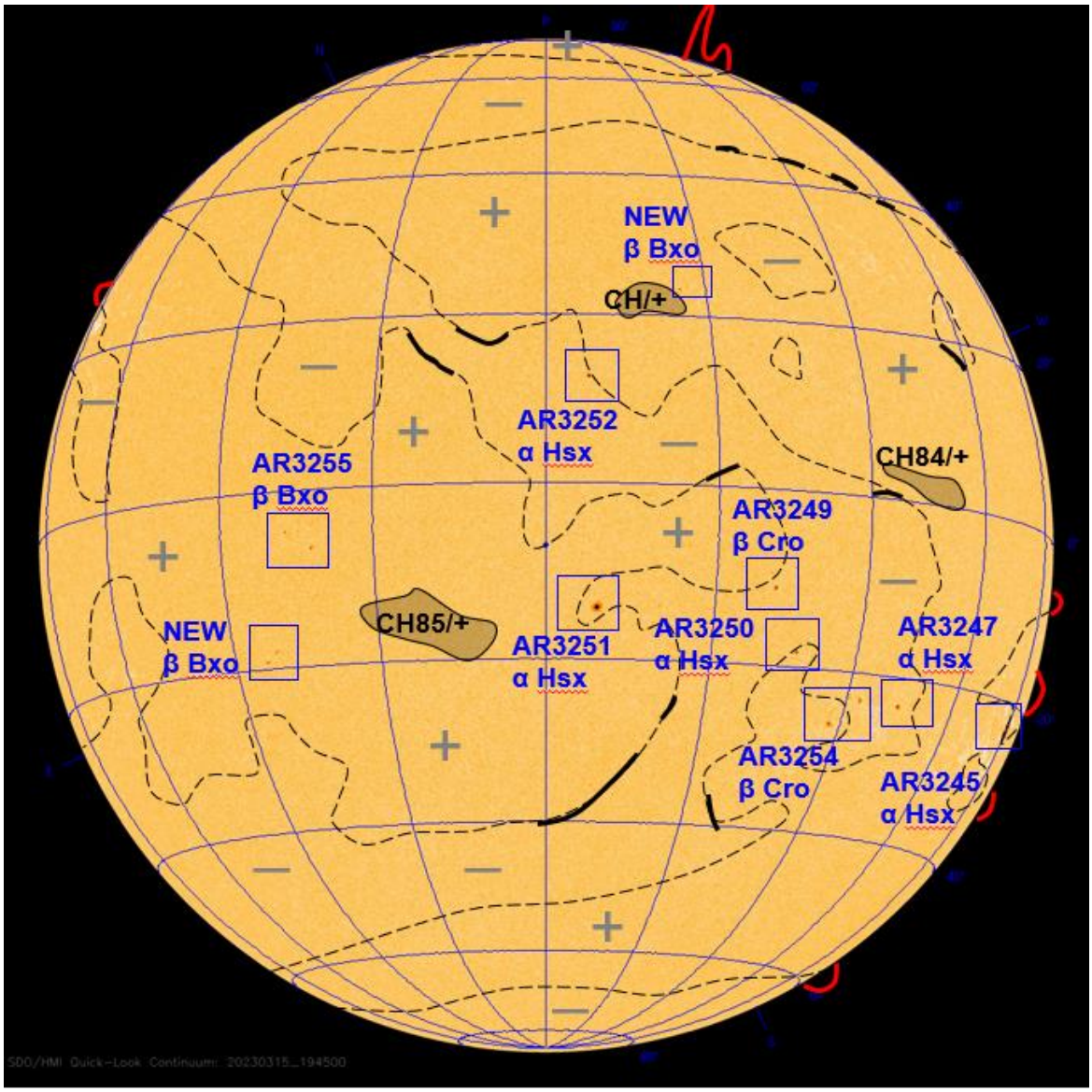
Geomagnetic activity most likely fluctuating between Unsettled to Active on Day 1 (16 March), with a chance of reaching G1/G2 Minor/Moderate storm due to potential combined HSS and CME effects. Activity should then gradually ease to mainly Quiet by Day 2 and 3 (17 and 18 Mar), with a possible further upturn in activity to Unsettled to Active by the end of the period.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux, as observed by GOES16, is expected to remain near background levels through the period. No further significant enhancements are expected at present. The high energy electron flux is expected to persist at largely Background levels on Day 1 (16 Mar), but is then likely to recover as the residual influence from CMEs and HSS wanes. Flux levels are likely to rise to Moderate, with a chance of reaching High levels by Day 3 (18 Mar). The associated 24 hour electron fluence is expected to persist at below the Active level, but with an upward trend.

Figure 1. Solar Analysis Valid 15/2000 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Figure 2: 24 hour solar wind data from DSCOVR.

Geomagnetic Storms:

Solar winds increased sharply at 15/0428UTC to elevated levels, near 570 km/s. This increase was likely associated with the arrival of a CME that left the Sun on 10 Mar. Further CME glances are possible on Day 1 (16 Mar) from the combined influence of filament eruption CMEs which left the Sun on 12 and 13 Mar, although these CMEs are expected to pass largely north and ahead of Earth. Solar winds are expected to vary between slightly elevated and elevated levels through Day 1, with coronal hole high speed stream effects combined with any further CME influence. Winds are expected to gradually decline into Day 2 (17 Mar), although perhaps remaining at slightly elevated levels throughout much of the rest of the period, with some further weak enhancement possible by the end of Day 4 (19th) from CH85/+.

Geomagnetic activity most likely fluctuating between Unsettled to Active on Day 1 (16 March), with a chance of reaching G1/G2 Minor/Moderate storm due to potential combined HSS and CME effects. Activity should then gradually ease to mainly Quiet by Day 2 and 3 (17 and 18 Mar), with a possible further upturn in activity to Unsettled to Active by the end of the period.

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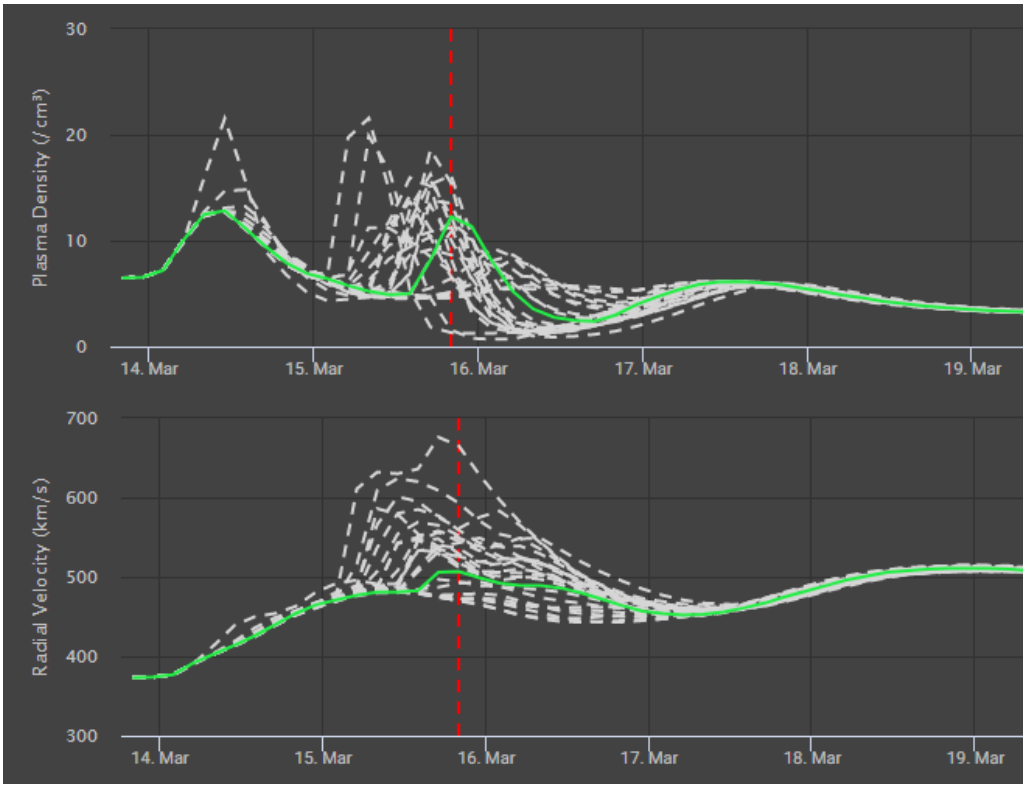
Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	50	10	1	10
Strong	G3	No	5	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
12/2340	Partial	Filament Eruption	SE	760 km/s	15/1800 UTC +/- 6 hrs	Glancing impact
13/1319	Partial	Filament Eruption	N	1330 km/s	15/1200 UTC +/- 9 hrs	Glancing impact

Figure 3: ENLIL Ensemble



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Met Office Space Weather Technical Forecast

Radio Blackouts - X-Ray Flares:

Solar activity has been Very Low to Low over the past 24 hours with just an isolated C-class flare at 15/0630UTC from AR3254.
There are currently eight numbered sunspot regions on the visible disc. These are a mixture of mature spots and some more recently emerged spot groups. All are small and magnetically simple, and either stable or in decay. Some minor new un-numbered spots have emerged in the northwest and southeast of the disc. In addition to the spots, there are number of filaments on the disc, which should any erupt, could be another source of C-class flares.
Solar activity is expected to continue to be Low or Very Low, with a slight chance of an isolated M-class flare. AR3245 (Hsx/Alpha) is approaching the southwest limb and is due to rotate off the visible disc in the next 24 hours. However, possible new or returning regions may rotate around the east limb during the forecast period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	5	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux increased to above the S1 level, likely due to the ongoing effects from the significant far-sided eruption early on 13 Mar, with a peak of 22pfu at 15/0425UTC. Proton flux then dropped below the S1 threshold around 15/0600UTC and continued on a downward trajectory towards background levels.
Given the simplicity of the sunspots currently on the disc, no further significant enhancements are expected, unless any further large far-sided eruptions occur.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	Yes	10	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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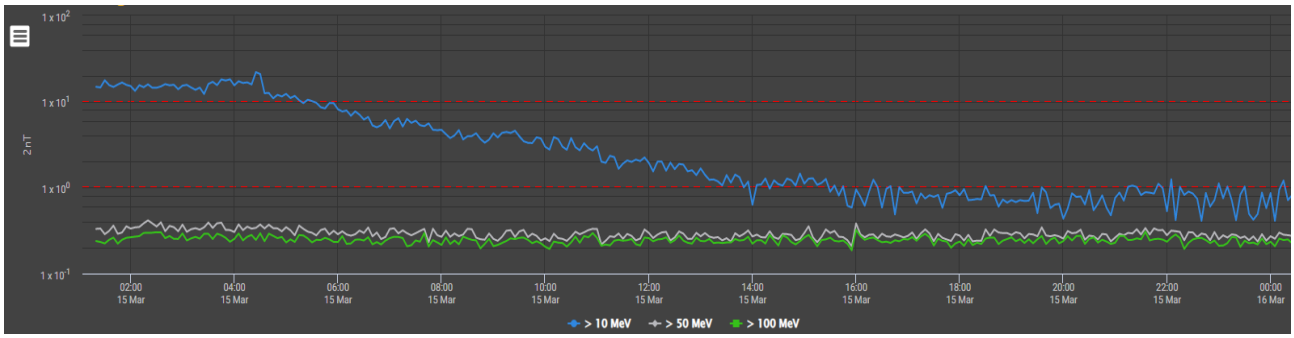
Figure 4: GOES-16 Proton flux



High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux at GEO, as observed by GOES-16, is expected to persist at largely Background levels on Day 1 (16 Mar), but is then likely to recover as the residual influence from CMEs and HSS wanes. Flux levels are likely to rise to Moderate, with a chance of reaching High levels by Day 3 (18 Mar).
The associated 24 hour electron fluence is expected persist at below the Active level, gradually trending upwards during Days 2-3 (17-18 Mar), with only a slight chance of the Active threshold being reached. REFM is currently considered to be giving good guidance for the overall trend.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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